

## REMARKS

### Claim Disposition

Claims 1 – 19 are pending in the present application. Claims 6 and 15 have been cancelled. Claims 1-5, 7-14, and 16-19 have been amended to more particularly point out and distinctly that which Applicant claims as his invention. Claims 20-23 have been added.

No new matter has been introduced by these amendments. Support for the amendments may readily be found throughout the Specification and examples of support for each amendment are set forth below.

Claim 1 has been amended to replace “fabrication of electrical contacts for” a molecular electronic transistor with “forming at least one nanometer-scale circuit comprising ... and electrical contacts therefor” to better describe Applicant’s invention. Support for this amendment can be found throughout the specification, at least in the first and second paragraphs of the “SUMMARY OF THE INVENTION,” page 18 of the application as filed (paragraphs 49 and 50 of the published application). In paragraph 50 it is stated:

The new field is called Molecular Electronics or "Moletronics," which utilizes chemical reactions to create batches of molecular-scale or nanometer-scale (one billionth of a meter-scale) circuits. (Emphasis added.)

Support is also found, *e.g.*, in the first line of the Abstract:

Electronic circuits based on molecular transistors, generally used in place of semiconductors. More particularly, the invention relates to a unique method of wiring of a three-terminal molecule... (Abstract.)

A molecular electronic transistor is the molecular-electronic device that is the focus of Applicant’s disclosure, including the drawings, and part of the title of the Application.

Further support for the amendment is found, *e.g.*, in the first line on page 2 of the application as filed, under “Field of Invention”:

The present invention relates to electronic circuits based on molecular transistors, generally used in place of semiconductors. More particularly, the invention relates to a unique method of wiring of a three-terminal molecule... (Paragraph 2 of the published application.)

Claim 1 has also been amended to better define the invention by deleting the potentially confusing phrase “or an aggregate thereof” with respect to wiring a three-terminal molecule. Support for this amendment can be found throughout the specification and drawings, wherein, in every case, it is always an individual molecule that is wired as a transistor. Applicant’s intent in initially using the phrase “or an aggregate thereof” may have been to indicate that he was disclosing, in one embodiment of the invention, an aggregate of molecules, each individually wired as a transistor. However, the phrase potentially confuses the disclosed nano-scale circuit, wherein a single molecule is the transistor, with a conventional organic or inorganic semiconductor, wherein the transistor properties are created by the structure of the assembly and wherein conductivity is a bulk property. In a conventional transistor, the semiconductor material itself does not have transistor properties.

Additionally, Claim 1 has been amended to provide that the three-terminal molecule that is wired is one “comprising a source terminal, a gate terminal, and a drain terminal.” Support for this amendment can be found throughout the Specification and drawings, at least in originally filed Claim 10, in Example 1, paragraph 85, and in Figures 4 and 5.

The term “molecular” was added to modify “electronic transistor” in line 5 of Claim 1, and “the molecule attached to” was added to line 6. As stated previously, support for the disclosed transistor being a “molecule” and/or comprising a molecule, is found throughout the Specification and drawings.

Further, in Claim 1, the deleted phrase, “for the creation enhanced integrated circuits” is a possible use of the invention and does not belong in the claim, so it was deleted to better conform with patent practice.

Lastly, in Claim 1, the final 4 lines “allowing the molecule to attach...” completes the method steps. The language of this amendment is supported throughout the Specification, for example, in example 1, paragraph 87, last two lines, describing self-assembly of the molecules into the circuit having a gap tailored to fit the length of the molecule (paragraph 86). See also, Claims 11 and 12.

Claims 2-5, and 7-14, dependent on Claim 1, were amended to agree with Claim 1 and to be correct grammatically.

In independent Claim 16, the preamble has been amended similar to the amending of the preamble in Claim 1. Also, in order to provide more acceptable method claims language, amendments such as “wiring” in place of “is wired;” “providing” in place of “is provided;” and “immersing” in place of “immersed;” have been made.

Also in Claim 16, the “phosphate group” alligator clip on the gate chain has been replaced with a “group that specifically attaches to a gate electrode, with the proviso that the alligator clip on the gate chain is not an –SH group;” and the aluminum gate electrode has been replaced with “a metal which couples specifically to the alligator clip on the gate chain.” A further amendment replaces platinum as the source / drain electrodes with “a metal which couples to the –SH alligator clips on the corresponding chain.”

Support for an alligator clip on the gate chain being other than phosphate, but not –SH, and the gate electrode being other than aluminum, and the source/drain electrode being a metal that couples to –SH alligator clips is found throughout the Specification, at least in paragraphs 55 (“other metals can be used”), 56, 93 and 94, Figures 4 and 5, and originally filed Claims 6, 10, 13, 14, and 15.

Claims 17-19, dependent on Claim 16, have been amended to agree with amended Claim 16 and to utilize better method claim language.

Support for new Claims 20 and 21 can be found in Claim 1 and throughout the Specification, and in Figure 5, wherein it is shown that the source, drain, and gate

electrodes can be three different metals. See also paragraph 60 of the published application.

Support for new Claim 22 can be found throughout the Specification and especially in Claim 1, Figure 4, paragraphs 86 and 87 of the published application.

Support for new Claim 23, dependent on Claim 22, can be found throughout the specification, especially in paragraph 36, and in Figures 4 and 5 which show molecules having a double-well potential structure.

Entry of the above amendments is requested. Additional remarks are set forth below with reference to the rejections in the Office Action. Reconsideration and allowance of the claims is respectfully requested in view of the above amendments and the following remarks.

#### **Claim Rejections Under 35 U.S.C. § 102(e)**

Claims 1-5 and 7-14 stand rejected under 35 U.S.C. § 102(e) as being anticipated by **Tanabe et al.**, U.S. Patent Publication 2004/0012018 A1, hereinafter referred to as "Tanabe".

Applicant has submitted herewith an Affidavit under 37 U.S.C. § 1.131, along with supporting Exhibits A through D, the Affidavit and Exhibits hereby incorporated by reference in this Response. Applicant submits that the showing of facts in the Affidavit and Exhibits is such, in character and weight, as to establish reduction to practice by Applicant prior to the effective date under 35 USC § 102(e), July 16, 2003, of the Tanabe reference, or conception of the invention prior to July 16, 2003 coupled with due diligence from prior to said date to a subsequent reduction to practice and/or filing of the application.

Based on the showing of facts in the Affidavit and Exhibit, Applicant respectfully requests that the rejection of Claims 1-15 based on Tanabe be withdrawn.

Additionally, or in the alternative, Applicant respectfully traverses the rejection.

The Examiner alleges that:

"Tanabe discloses a semiconductor process as claimed. See Figs 1-8, where Tanabe teaches the claimed limitations."

The Examiner does not state or suggest that Tanabe claims Applicant's invention.

With regard to Claim 1, Tanabe is cited in the Office Action for allegedly teaching

“a method of fabrication of electrical contacts for molecular electronic transistors, comprising the steps of:

wiring a three-terminal molecule or an aggregate thereof to serve as an electronic transistor, the electronic transistor comprising a gate electrode **14**, a source electrode **11**, and a drain electrode **15**, wherein the source electrode and the drain electrode are fabricated from a first previously-determined metal (platinum, palladium, chromium) and the gate electrode is fabricated from a second previously-determined metal (aluminum, copper, nickel, chromium or an alloy thereof), functioning to allow for simultaneous attachment of molecules to the source electrode, drain electrode, and gate electrode in a previously-determined order, for the creation enhanced integrated circuits.”

Applicant respectfully disagrees and contends that Tanabe, whether alone, or in combination with any of the references of record, does not teach or disclose each element of Applicant's invention. Applicant first, respectfully directs the Examiner's attention to note that independent Claim 1 has been amended to further clarify the invention. Claim 1 has been amended to recite, for example,

“A method of forming at least one nanometer-scale circuit comprising a molecular electronic transistor and electrical contacts therefor, the method comprising the steps of: wiring a three-terminal molecule comprising a source terminal, a gate terminal, and a drain terminal to serve as a molecular electronic transistor...”

Applicant discloses and claims a molecular device. Applicant teaches a molecular transistor. In one embodiment, *e.g.* the transistor may be shaped like the letter T, whose top represents the transistor channel, and whose stem represents the transistor's gate. The molecular transistor is equipped with alligator clips that can attach themselves to the respective electrodes exclusively. As such the transistor has a built in logic that tells the molecule how to organize itself in the electronic circuit. Applicant teaches use of a molecule that has the transistor properties built in, transistor properties that are operating by a different mechanism from the one described by Tanabe.

Applicant teaches one embodiment that is a molecular electronic transistor that operates with non-classical behavior by having a single double-well potential molecule, which embodies two different molecules included in the same molecular structure, one with an insulating chain (the T top) and one with a conductive chain (the same T top). An electric field (applied by the gate electrode along the T stem) can switch between the molecular states, and switch the electrically insulating T top of the molecule to an electrically conductive T top, by transferring an electron from the T top to the T stem.

See, e.g., Fig. 2 which depicts a molecular electronic transistor which is shaped like the letter T, wherein the T-top represents the transistor channel, and the T-stem represents the transistor's gate.

Applicant's disclosed molecular transistor operates as a single electron tunneling transistor. The quantum mechanical explanation of a double well potential molecule is not straight forward, but is understood by those of skill in the quantum mechanical field.

In a double well potential molecule, there are two ground states for a single electron, one with its waveform localized in a first well and another with its waveform localized in the a second well. In the case wherein a double well potential is symmetric between the two wells, the electron must have an equal probability of being in either well. This is believed to occur by the quantum mechanical phenomenon of tunneling. There is a nonzero probability for the electron to tunnel through the intervening barrier from one well to the other! This is a non-classical behavior. The electron, having tunneled from the first well to the second, now has some probability of tunneling back to the first well, a recurring phenomenon! An electric field can induce an electron to switch from one well to the other.

Applicant teaches a method of wiring the single molecule as a transistor in a nano-scale circuit. In one embodiment, there are two dissimilar electrodes made of metal 1 for the source / drain electrodes, and metal 2 for the gate electrode.

Coupled to that notion, the molecule contains specific “alligator clips” on the transistor terminals, that bind specifically to the right electrodes. Thus the device has a built-in logic that directs a molecule to its exact attachment locations to attach the gate terminal to gate electrode, source terminal to source electrode.

Applicant teaches a transistor that is a molecular device with the transistor properties built into the molecule itself, and teaches a novel “lock and key” invention for directing the molecule to a specific location and placing the molecular transistors in the circuit.

Tanabe teaches a conventional semiconductor device analogous to CMOS devices. Tanabe teaches an organic semiconductor device that relies on bulk semiconductor material properties (albeit organic). Tanabe teaches a device consisting of a structure of layers that form a three-dimensional structure consisting of the following arrangement: an insulating planar substrate upon which is deposited the transistor; a metal electrode (transistor’s gate electrode); a gate insulator layer, which covers the whole gate electrode; two metal electrodes (source / drain electrodes) deposited on top of the gate-insulator layer, with a gap that exposes a portion of the gate-insulator layer, precisely located over the gate electrode; an organic semiconductor material that is deposited in the electrode gap, above the gate insulator, and touching the source / drain electrodes.

Tanabe teaches a device identical in concept and in structure to a conventional CMOS transistor used commercially in many applications such as logic, memory and display devices. The only difference between Tanabe and other commercially available transistors is the organic semiconductor material, which replaces inorganic semiconductor materials such as silicone, gallium-arsenide, tin oxide, polysilicon, germanium, *etc.*

Tanabe also teaches a conventional fabrication process for the device. The structure is accomplished by building layer upon layer with the help of lithographic procedures to place the layers in specific locations, and by vapor-deposition techniques, for depositing the metals, the insulators and the semiconductor. The

result is a three-dimensional labyrinth. The dimensions of the device are suitable for micro-scale devices, in line with conventional practice in the semiconductor industry. Tanabe relies entirely on known lithographic techniques for placement of the device components.

Tanabe teaches a transistor that operates by changing the conduction in the so-called "Depletion Layer" of the transistor by an electric field applied through the gate electrode. The Tanabe device is different from Applicant's device in concept, in the mode of fabrication, and in the mechanism of operation.

Tanabe's teaches a conventional semiconductor device analogous to CMOS devices, the Tanabe device relying on bulk organic semiconductor material for transistor properties.

Tanabe does not teach or suggest "a method of forming at least one nanometer-scale circuit comprising a molecular electronic transistor and electrical contacts, the method comprising the steps of: wiring a three-terminal molecule..." Tanabe does not teach a molecule that has the transistor properties built in. Tanabe does not teach the wiring of a single molecule. In fact, no molecule taught by Tanabe as useful in a transistor could actually be wired as a molecular transistor.

Applicant respectfully contends that Tanabe, whether alone or in combination with other references of record neither teaches, discloses, nor suggests the numerous elements of Applicant's Claim 1, and therefore Tanabe cannot render it unpatentable. Thus, Claim 1 is patentable; the rejection is improper and should be withdrawn.

In view of the above discussion, Claims 2 – 5, and 7-14 depend from Claim 1, and include all of the corresponding limitations thereof. Thus, Claims 2 – 5, and 7-14 are allowable; the rejections are improper and they should be withdrawn.

#### **Claim Rejections Under 35 U.S.C. § 102(b)**

Claims 16-19 have been rejected under **35 U.S.C. § 102(b)** as being anticipated by **Kelley et. al**, U.S. patent No. 6,433,359 B1, hereinafter 'Kelley'. The Examiner alleges



that Kelley discloses a semiconductor process as claimed, and states that Kelley teaches the claimed limitations in Figs. 1-3.

Applicant respectfully disagrees and submits that Kelley, whether alone, or in combination with any of the references of record, does not teach or disclose each element of Applicant's invention. Applicant first, respectfully directs the Examiner's attention to note that independent Claim 16 has been amended to further clarify the invention as a molecular electronic transistor. As amended, Claim 16 is directed to:

"a method of forming at least one nanometer-scale circuit comprising a molecular electronic transistor and electrical contacts therefor, the method comprising: wiring a molecule comprising a source/drain chain and a gate chain as a transistor by distinguishing between a source / drain metallurgy and a gate metallurgy, and by providing previously-determined alligator clips which function to direct the molecule toward a proper connection..."

Applicant discloses and claims a molecular device and method of fabricating it. Applicant teaches a molecular transistor wherein the organic molecule is itself the transistor having three terminals that are connected to three electrodes in a proper order.

Kelley does not deal with this type of molecule or with wiring a single molecule. Nor could any of the molecules taught by Kelley be used as a transistor. Kelly teaches a CMOS type transistor, where the semiconductor material is an organic semiconductor replacing silicon. Thus, the organic film that Kelly interposes between the semiconductor and the gate electrode is a benign insulator which replaces the function of the well known "gate oxide" that is an essential part in a CMOS transistor.

Kelley teaches an improvement to an organic semiconductor transistor (not a molecular device) by insertion of an organic monolayer between the semiconductor gate and the gate dielectric. The organic monolayer has the structure x-y-z where x is always hydrogen and z is a group that binds to surfaces by self-assembly. Thus, the monolayer is bound to the semiconductor-dielectric interface through only one terminal (z). The transistor described is conventional, where the transistor properties are created by the structure of the assembly. The semiconductor material itself, as taught by Kelley, does not

have transistor properties. Conductivity of Kelley's semiconductor material results from bulk properties. Kelley does not teach Applicant's claim limitation of: "wiring a molecule comprising a source/drain chain and a gate chain as a transistor..."

In contrast to Kelly's transistor, Applicant teaches a molecular transistor, wherein a single molecule has transistor properties and is wired according to an embodiment of the invention. Furthermore, there are two other distinctions: In conventional three-terminal transistors such as Kelley's, at least two electrodes are deposited ON the semiconductor layer. In contrast, Applicant teaches a process wherein the molecule is deposited when all the electrodes are in place, in specific accommodating gaps provided in advance.

In conventional transistors such as Kelley's, the semiconductor material does not require any specific orientation. In contrast, in molecular electronics alignment of the molecule in a specific order must be achieved. Because the molecule in itself is a transistor, the gate terminal on the molecule has to be attached only and specifically to the gate electrode, and the source electrode must be connected to the source site on the molecule. By the same token, the drain electrode must be connected to the drain site on the molecule.

Kelley does not teach all of the limitations of Applicant's claimed process or a transistor made according to the disclosed process, comprising:

forming at least one nanometer-scale circuit comprising a molecular electronic transistor and electrical contacts therefor, the method comprising: wiring a molecule comprising a source/drain chain and a gate chain as a transistor by distinguishing between a source / drain metallurgy and a gate metallurgy, and by providing previously-determined alligator clips which function to direct the molecule toward a proper connection...

Applicant respectfully submits that, Kelley, whether alone or in combination with other references of record, does not teach, disclose, or suggest the numerous elements of Applicant's Claim 16, and therefore Kelley cannot render it unpatentable. Thus, Claim 16 is patentable; the rejection is improper and should be withdrawn.

In view of the above discussion, Claims 17-19 depend from Claim 16, and include all of the corresponding limitations thereof. Thus, Claims 17-19 are allowable; the rejections are improper and they should be withdrawn.

To anticipate a claim, a reference must disclose each and every element of the claim. *Lewmar Marine v. Varient Inc.*, 827 F.2d 744,747, 3 U.S.P.Q.2d 1766, 1768 (Fed. Cir. 1987), *cert. Denied*, 484 U.S. 1007 (1988). Because both Tanabe and Kelley are missing at least one element of Applicant's claims, neither Tanabe nor Kelley can anticipate the present claims. As described above, there are clear differences in the structure, physical properties, and mechanism of operation between Applicant's claimed invention and that of either Tanabe or Kelley, alone or in combination. Tanabe and Kelley both teach a conventional transistor, wherein the semiconductor material itself does not have transistor properties. Applicant teaches a molecular electronic transistor wherein the molecule itself is the transistor and is wired in a nano-scale circuit.

None of the references cited by the Examiner, either alone or in combination, contain all of the elements of Applicants' claims as amended. Therefore the claims meet the requirements of 35 U.S.C. § 102 (e),(b) and 35 U.S.C. § 103 (a).

The amendments and arguments presented herein are made for the purposes of better defining the invention, rather than to overcome the rejections for patentability. The claims have not been amended to overcome the prior art and therefore, no presumption should attach that either the claims have been narrowed over those earlier presented, or that subject matter or equivalents thereof to which the Applicant is entitled has been surrendered.

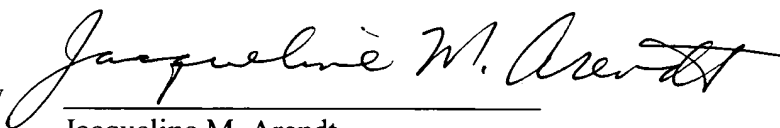
### CONCLUSION

It is believed that the foregoing remarks are fully responsive to the Office Action and that the claims herein should be allowable to the Applicant. Accordingly, reconsideration and allowance of Claims 1 – 5; 7-14; and 16-19 are respectfully requested. Entry, examination, and allowance of new Claims 20- 23 is also requested.

In the event the Examiner has any queries regarding the instantly submitted response, the undersigned respectfully requests the courtesy of a telephone conference to discuss any matters in need of attention.

Respectfully submitted,

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**IN THE DRAWINGS:**

The attached sheets of drawings include changes to Figures 1, 2, 3, 4, and 5 and replace the original sheets 1-5. The original drawings for Figures 1-5 on sheets 1-5 had lines that were fuzzy or “smudged” in appearance. The Replacement Sheets for Figures 1-5 have clear, even lines of uniform thickness. No other changes were made to Sheets 1-2.

In Figure 3 on Replacement Sheet 3, “S” and “D” are replaced by the complete words “Source” and “Drain”, respectively.

The original drawings for Figures 4 and 5 on sheets 4 and 5 did not show the electrode connections. In accordance with the Examiner’s instructions, Replacement Sheets for Figures 4 and 5 show the electrode connections, as described in Replacement paragraphs 0083 and 0084 on page 3 of this Response, wherein the Specification is amended to correct the description of the drawings, Figures 4 and 5.

No new matter is added by this amendment, as support is found throughout the specification, wherein it is noted that different alligator clips attach specifically to certain metals, and in original claims 6, 10, 13, 14, 15, 16, and 18.

Five sheets marked “Annotated Sheet Showing Changes” and five corresponding sheets, each of which is marked “Replacement Sheet” are enclosed.

1/5

Cleaner lines  
of uniform thickness:

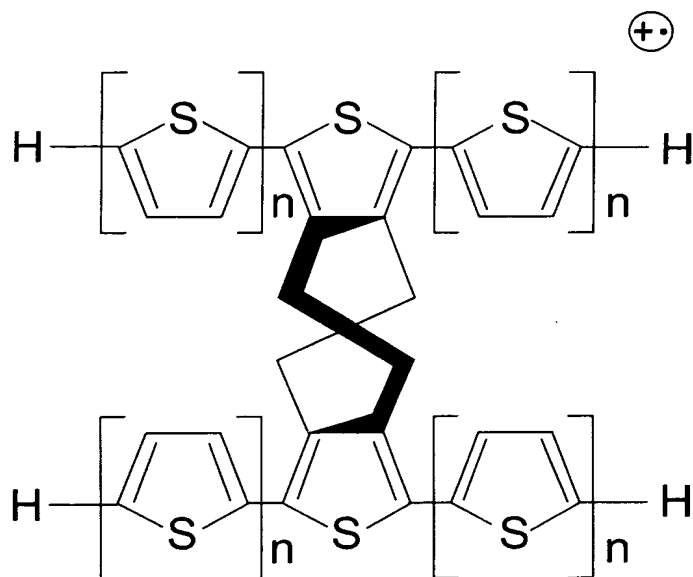


Figure 1

2/5

Cleaner lines of  
UNiform thickness

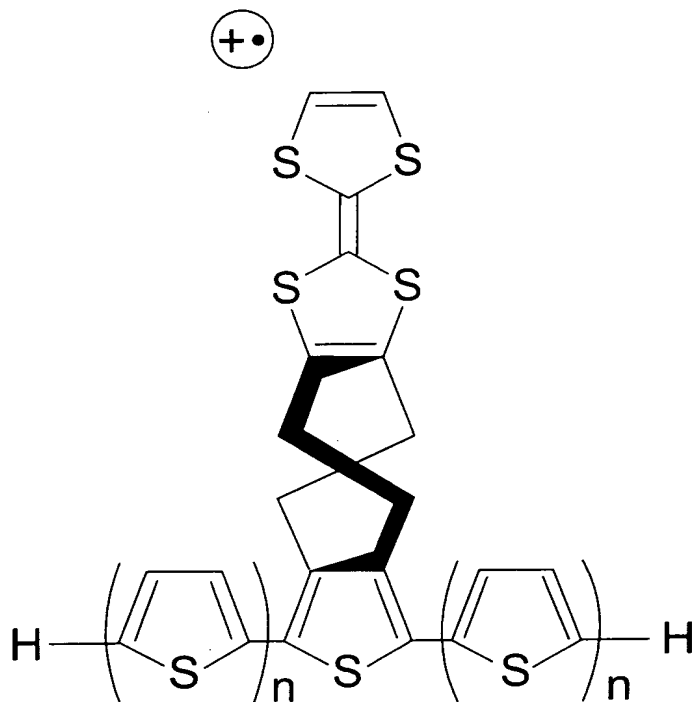


Figure 2

3/5

Cleaner lines  
& uniform thickness

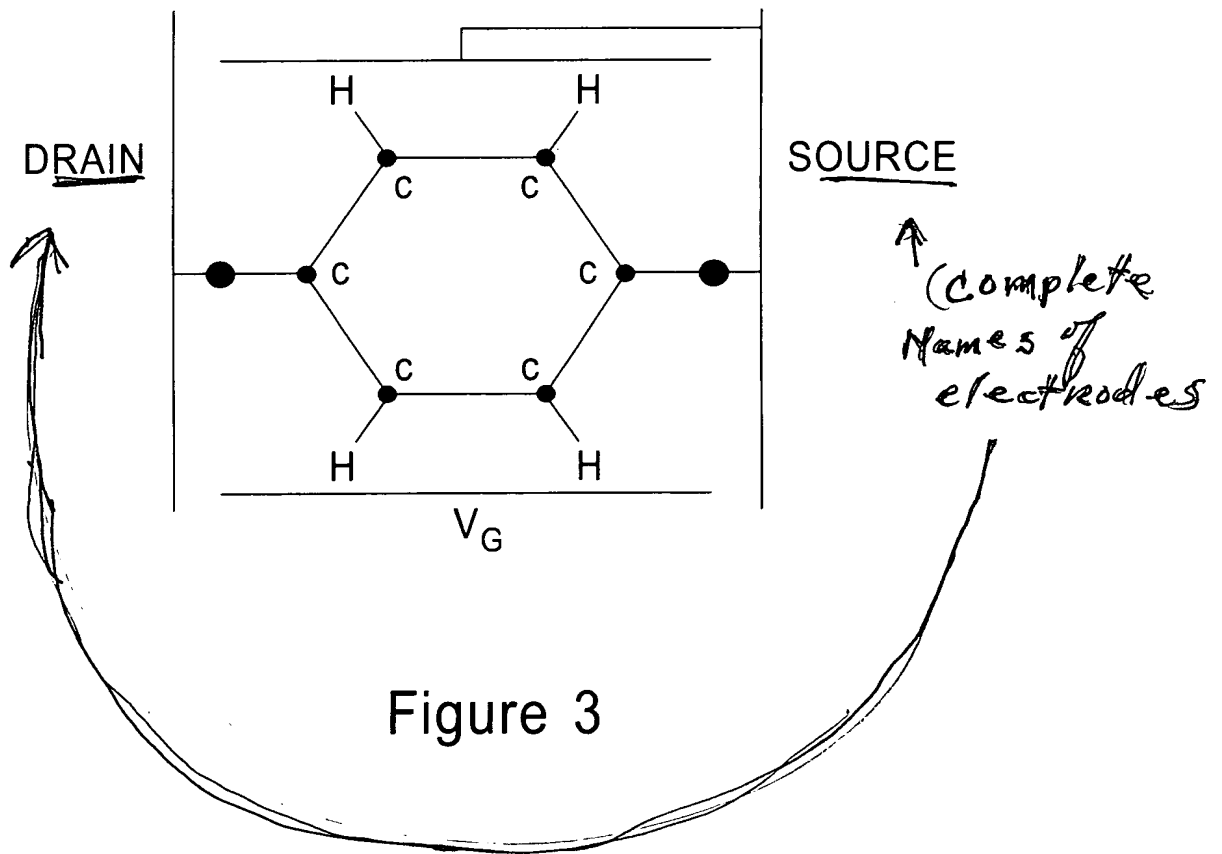


Figure 3



4/5

Cleaner lines  
of uniform thickness

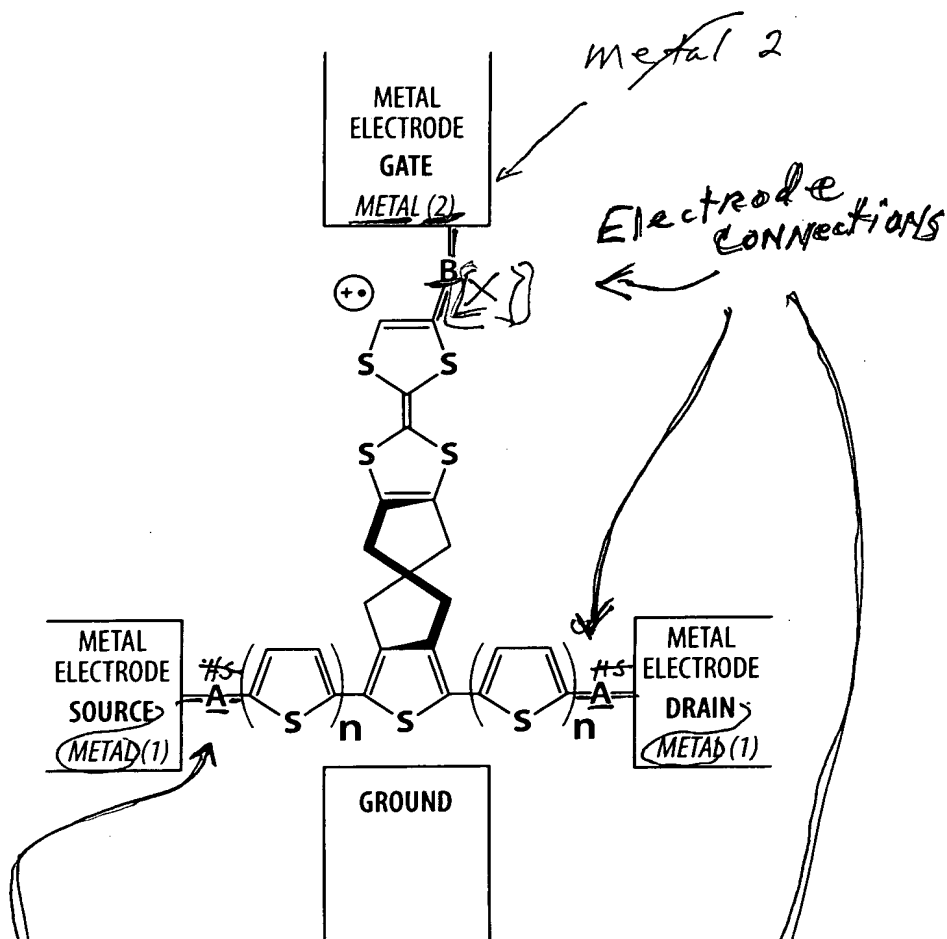


FIGURE 4

5/5

Cleaner lines of  
uniform thickness ↘

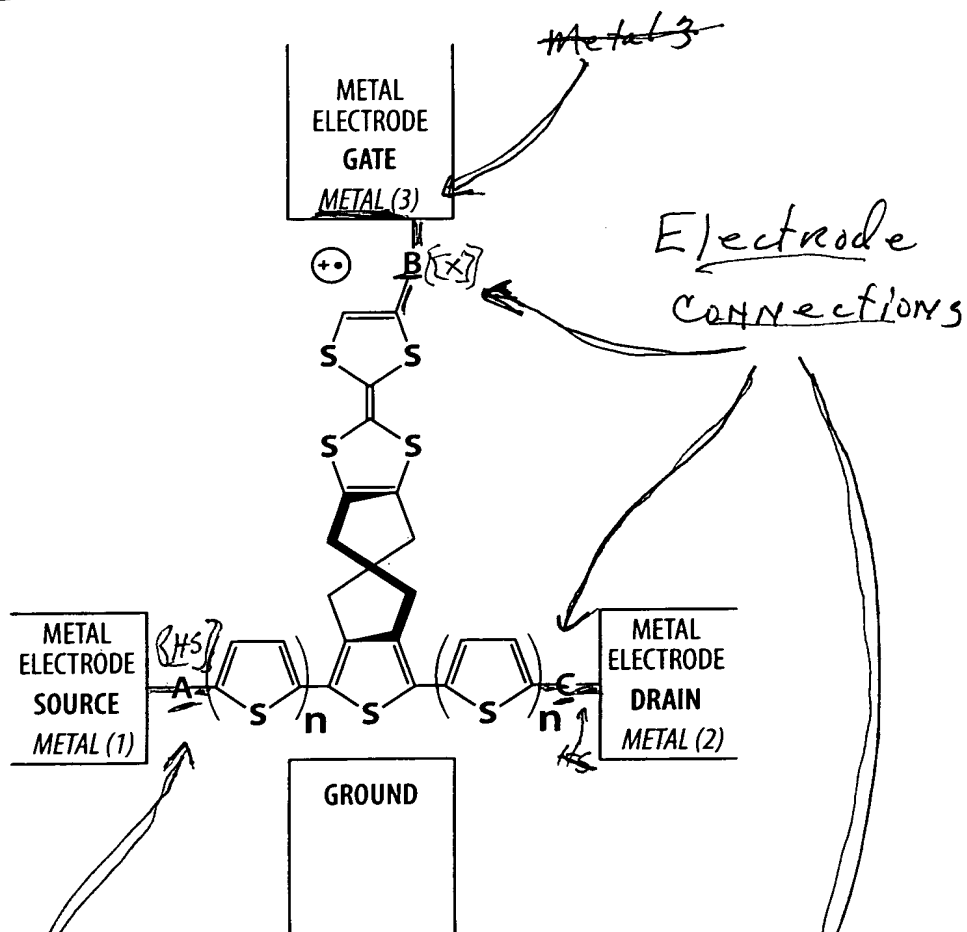


FIGURE 5